LUBRICATION

Published by THE TEXAS COMPANY

17 Battery Place, New York

Copyright, 1916, by The Texas Company

Edited by

L. H. CANFIELD, Ph. D.

VOL. III OCTOBER, 1916 No 12

Published Monthly in the interest of efficient lubrication.

Change of Address—In reporting change of address, give both old and new address.

Correspondence is invited. Address all communications to Dr. Canfield.

CONTENTS

Editorials – – – – – – – – 1

Lubricating Oils, The Examination, Laboratory and Practical Methods of Testing – – – – – – – 3

Texaco Products in the United States Navy – – – – – – 14

EDITORIAL

Was your copy of this issue of "Lubrication" correctly addressed? In a mailing list as large as ours, mistakes are bound to occur, particularly in view of the fact that many names are sent in to us in handwriting which we are not always able to decipher. We are making an effort to correct all errors, and will appreciate your co-operation if you will notify us of any mistake in your address.

Lubricating engineering is at last beginning to receive a share of the attention which is warranted by its importance. A few years ago it was customary to open an article on Lubrication or Lubricating Oils with a statement to the effect that the author was dealing with a neglected subject. At the present time, however, the subject of lubrication is being discussed pretty generally and many misconceptions of long standing are being cleared up. The Texas Company is, of course, very modest in the matter, but we are quite willing to have the question raised as to how much credit is due to The Texas Company for stimulating interest in such an important subject as lubrication, and for throwing light on many of its ill-understood phases.

The article on "Lubricating Oils" by Lieut. J. L. Kauffman, which is reprinted in full in this issue, gives a complete understanding of the tests to which oils are submitted before being used by the U. S. Navy. This article is of primary interest to us as a very large percentage of the oils used by the Navy is furnished by The Texas Company. The fact should be emphasized very strongly that in awarding the naval contracts for lubricating oils the government requires satisfactory practical service before even considering price.

Another excellent article on "The Properties of Oils and their Relation to Lubrication" by Geo. B. Upton, Assistant Professor in Experimental Engineering, Sibley College, Cornell University, appeared in the June, 1916, issue of the

Sibley Journal of Engineering. In this article the various tests are covered briefly. Prof. Upton says among other things that the color of the oil has no connection with lubrication, that the flash and fire tests which were originally introduced because of fire risks, are now, except in special cases, of little consequence. He says that the practical upper temperature limit for the use of an oil as a lubricant occurs below the flash point because of the decrease of viscosity of the oil with rising temperature. As the author expresses it, "We test for flash and burn points, therefore, to catch any oil which might bring fire risk from having these points too low, and to be sure that the flash point occurs at a temperature higher than the highest temperature at which the oil is to act as a lubricant."

In regard to the *Emulsion Test*, Prof. Upton says:

"A very simple test to check the purity of a mineral oil is the emulsion test. Fill a clean bottle about a quarter full of clear water (preferably distilled) and another quarter full of the oil. Shake vigorously until oil and water form an emulsion. Allow to stand for 24 hours. A pure distilled mineral oil separates completely from the water, which remains clear. Acids, soaps, rosins, etc., make emulsification easier, prevent the complete separation of oil and water, and leave the water cloudy. There will often be, after the separation, a layer of leathery foam between the oil and the water. The emulsion test is a rough one; it takes a chemical analysis to work out the real reasons for the actions shown. The fact that an oil will or will not readily form an emulsion with water is often of importance in judging whether the oil will feed or not, as an oil pump suction will not work on the foam."

Prof. Upton makes the following statements concerning *Cold Test*:

"The temperature at which, in cooling, oil first gets too stiff for gravity flow is called the temperature of the pour test. Since gravity flow is very commonly relied upon to move the oil along feed pipes to bearings, cooling below the pour test temperature stops the feeding of the lubricant. On this account the pour test is of considerable importance as a low temperature limit to the use of the oil. . ."

As regards gravity the article states:

"Density of oils is probably the property most often misunderstood and misinterpreted. . . . . "

"Density of oils has nothing to do with lubrication by the oils; lubrication does not depend in any way upon density as a specific property of the oil. When we speak of oils as 'light,' 'medium' or 'heavy,' the property concerned is viscosity. 'Light' means low viscosity; 'heavy' means high viscosity. These technical usages of the words 'light' and 'heavy' are extremely unfortunate and highly misleading. They go back historically to a time when it was thought that oils of high viscosity were necessarily also of high density. That there is no such connection between the two properties may be readily brought out by citing liquids other than oils. Three common liquids have the properties at zero degrees Centigrade: water, density 1.00, viscosity 0.018 c.g.s. units; mercury, density 13.60, viscosity 0.017; glycerine, density 1.27, viscosity 46.0. It is true that oils made by the same process from the same crude oil have higher densities as they have higher viscosities; but change of process with the same crude oil as base slightly dislocates this relation of density and viscosity, and change of the crude oil entirely dislocates it."

"What the density does tell concerning the oil seems to be the source of the oil—what kind of crude oil was used. . . . . "

Prof. Upton's attitude toward viscosity is shown by the following statements:

"Viscosity is the most important property of oils as regards lubricating action. It is practically the controlling factor, so far as the oil is concerned, in the formation and maintenance of the oil film between metal parts when the parts are in motion. Viscosity is the internal friction of fluids, the force resisting the movement of one layer of oil past the next. A liquid which, like steam engine cylinder oil or tar, is 'thick' or 'stiff,' and does not flow readily, has high viscosity; a liquid which is 'thin,' flows readily, like water, has a low viscosity. . . . . "

"When a shaft is at rest in a bearing, with load on, the shaft and bearing are in metallic contact on the side toward the load. The shaft being smaller in diameter than the inside of the bearing, there remains a thin crescent-shaped space between shaft and bearing metal on the side away from the load. This space will fill with oil, while the shaft is at rest, by the action of surface tension or capillarity, even against the action of gravity."

"When the shaft starts to turn, oil sticks to the shaft and tends to carry around with the shaft to form a film of oil between shaft and bearing on the side toward the load. The bearing, because of the load, tries to wipe this oil off the shaft, or to prevent the oil from going through. The oil layer in contact with the bearing metal stays stationary in any case. The result of the actions of the moving shaft and the stationary bearing metal is a motion of oil layer on oil layer, a motion which brings in the forces due to viscosity of the oil."

". . . . . The oil film must of course always be thinner on the load side than on the unloaded side, but with good lubrication the shaft does come appreciably near to running concentric with the bearing. In other words, the thickness of the oil film toward the load, where the film is thinnest, approaches as a limit, but does not reach, one-half the clearance. There is thus a mechanical limit to the thickness of the oil film."

"Excessive friction in machinery may occur therefore from either too low or too high a viscosity of the oil. Too low viscosity means that the oil film is not maintained. Too high viscosity, while the oil film is 'perfect,' gives excessive friction in the oil itself. Anyone who has cranked an automobile engine in the winter time appreciates the possibility of having too much viscosity in the oil. Too low a viscosity, with seized bearings, wrecks the machinery; too high a viscosity causes no damage to bearings, but is inefficient. The highest efficiency comes from going as near to seizing as we dare, while still playing safe."

LUBRICATING OILS

The Examination, Laboratory and Practical Methods of Testing *

By Lieut. J. L. Kauffman, U. S. Navy

This article will deal with the lubricating oils used in marine service, having the special requirements of the naval service particularly in view.

Up to about five years ago the Navy Department issued specifications covering each oil required; these specifications called for a certain flash point, specific gravity and viscosity, and usually enumerated several simple tests that would be made. This practice was similar to the practice of all railroads and industrial corporations, and one which is still followed by a few large firms. A few years after the establishment of the Engineering Experiment Station at Annapolis, Md., the study of lubricating oils was taken up and simple tests were made on oils purchased for naval use. The continued examination of oils developed a number of special tests which finally led to a change in the method of purchasing lubricating oils.

Instead of requiring all oils submitted by prospective bidders to meet definite specifications, each oil was required to pass satisfactorily the tests made at the Engineering Experiment Station before it was placed on the acceptable list. A memorandum was issued to all firms bidding on the Navy contracts setting forth in a general way the tests that would be made on the various oils. The old method had the dis-

* Reprinted by permission from the August, 1916, issue of the *Journal of the American Society of Naval Engineers*, p. 692, *et seq.*

advantage that an oil could be submitted which would meet each item of the specifications and still would not lubricate properly; also the requirements of the old specifications regarding specific gravity and flash point were found to limit the number of competing firms without increasing the lubricating value of the oils submitted. The memorandum issued by the Bureau of Steam Engineering of the Navy Department has been changed several times, each time broadening the requirements in a few particulars and narrowing the requirements in others.

The important paragraphs of the recent memorandum are given below:

(a) "All oils not known to be satisfactory are subject to test at the Engineering Experiment Station, Annapolis, Md., and to a further test in service on board ship when considered necessary, before being considered acceptable by the Bureau of Steam Engineering.

(b) "The complete test of an oil consists of three parts, namely: chemical, physical and practical tests.

(c) "To successfully pass the chemical tests all oils should be neutral in reaction and should not show the presence of moisture, matter insoluble in petroleum ether (hard asphalt), matter insoluble in ether alcohol (soft asphalt), free sulphur, charring or wax-like constituents, napthenic acids, sulphonated oils, soap, resin, or tarry constituents, the presence of which indicates adulteration or lack of proper refining. Except in oil for engines without forced lubrication, no traces of fixed oils (animal or vegetable fats) should be found.

(d) "In lubricating oil for main engines without forced lubrication, approved fixed oils, such as rape seed, olive, tallow, lard and neats-foot oil may be used. When the above fixed oils are used they will be well refined with alkalies, unadulterated, containing a minimum of free fatty acids, with no moisture or gumming constituents. Olive oil should not have a high specific gravity. If satisfactory emulsifying results can be obtained with straight mineral oils on engines without forced lubrication they may be submitted for service test.

(e) "The physical tests applied to each oil are as follows:

"1. Specific gravity—pyknometer.
"Baumé gravity.

"2. Flash and fire point (Cleveland open cup, Pensky-Martin closed cup).

"The flash point should not be below 300 F., closed cup; and for steam cylinder oil not below 450 F.

"3. Cold point—The cold point should not be above 32 F., except for cylinder oils. For ice-machine oils it should be as low as possible, at least low enough for the operating condition of minus 15 F. in a dense-air ice machine.

"4. Viscosity—The Saybolt Standard Universal Viscosimeter is used. The viscosity of the oils must be sufficient for the purpose intended, and, except for ice-machine oils, must not be less than 140 seconds at 100 F. Viscosity is taken at 100, 130 and 210 F.

"5. Emulsion Tests—Emulsion tests are made on all straight mineral oils, except cylinder oils. Four emulsion runs are made, using 40 c. c. of oil in each case and

(a) 40 c. c. of distilled water;
(b) 40 c. c. of salt water;
(c) 40 c. c. of normal caustic soda solution;
(d) 40 c. c. of boiling distilled water.

The mixture is stirred with a paddle for five minutes at 1,500 revolutions per minute, the mixture being kept at a temperature of 130 F. during the stirring and while settling out. On oils used with forced lubrication or on ice machines the oil must completely settle out in less than 20 minutes.

"6. Friction tests are made on the Experiment Station friction machine to determine the relative friction of various oils under varying conditions of speed, bearing-cap pressure and temperature.

(f) "Practical tests of oils for forced lubrication are made on the Engineering Experiment Station's 75-kw. turbo- generator, making 2,400 revolutions per minute, with the temperature of the bearing varying from 180 to 210 F. Tests of ice-machine oils are made on the ½-ton Allen Dense-Air Ice Machine. These tests cover a working period of at least 100 hours.

(g) "Upon completion of the tests at the Engineering Experiment Station a service test is usually recommended on all but cylinder oils. These tests are made on ships in commission, and cover a period of several months.

(h) "Oils should be submitted as follows:

"1. Three oils (light, medium and heavy) to be suitable for turbines, all forms of forced-feed or splash lubrication, dynamo engines, and all internal-combustion engines (including Diesel type). These three oils should cover the required range of viscosity.

"2. Marine-engine oils suitable for main engines without forced lubrication. This oil should form an emulsion when mixed with water, and may be either a compounded oil or a straight mineral oil. This oil must feed efficiently with wick feed, and not be washed off when mixed with water.

"3. An oil for use on ice machines in both the compressor and expander cylinders. This oil should not give off an objectionable odor when used with the dense-air ice machine.

"4. An oil for steam cylinder lubrication. This oil must be a straight mineral oil.

"5. Oil for steam cylinders using superheated steam. This oil will be used on shore stations and should have a high flash point.

The tests enumerated above will be described in a general way.

Chemical Tests

Moisture—Heat 3 to 4 c. c. in a test tube (the walls of which have been thoroughly wet with oil) in a bath of liquid paraffine up to 300 F. Oils containing water will form emulsions on the walls, also cause foaming and spluttering. A test is also made with a mixture of oil and eosin to determine faint traces of moisture by changes of color. The presence of moisture is particularly undesirable in transformer oils, but there is danger of its forming objectionable emulsions in any straight mineral oil.

Sulphur—Boil about 50 c. c. of oil with a piece of bright metallic sodium for half an hour; add water, heat and stir until sodium is dissolved; pour off water and test remainder with a fresh 1 per cent solution of sod um nitro prusside. If the mixture turns violet color the oil contains sulphur. When sulphur is found an additional test for sulphonated oils is made.

Acids or Alkalis—Heat for ½ hour with frequent stirring 25 c. c. of oil and 50 c. c. of neutral distilled water. Test a few c. c. of the mixture first with methyl-orange to determine the acids, and another portion with phenolphthalein for the determination of alkalis. Acids and alkalis cause emulsions. Acids also cause corrosion of journals and other metal parts.

Matter insoluble in ether alcohol—Shake 11 c. c. of oil and 14 c. c. of ether alcohol (8 parts ether and 6 parts alcohol). After standing 12 hours, note the precipitate, if any, at bottom of cylinder. The precipitate will be asphalt, and even a trace would make the oil undesirable as a lubricant. Asphalt would cause scoring of journals and clogging of oil lines.

Matter insoluble in h gh-grade gasoline—Shake 3 c. c. of oil and about 300 c. c. of high-grade gasoline (86-88 Baumé gravity). After standing 12 hours, note precipitate, if any, in bottom of glass. The precipitate will be soft asphalt or carbon particles, and a slight trace would make the oil undesirable.

Tarry or Suspended Matter—Same as above, except using 5 c. c. of oil and 95 c. c. of gasoline, and allowing it to stand for ½ hour; then examine deposit, if any, for dirt or tarry matter.

To Detect Fixed Oils—Heat 10 c. c. of oil with a small piece of metallic sodium. If the mixture becomes gelatinized or a semi-solid it indicates the presence of fixed oils. If an equal volume of oil is heated alone to the same temperature the viscosity of the two samples can be compared; if

the oil contains fixed oils (animal or vegetable oils) the sample with sodium will be much heavier than the sample heated alone. Straight mineral oils are used for all naval purposes afloat except on marine engines without forced lubrication; and experiments are being made to determine whether or not a straight mineral oil can be used for the latter; an oil being required which will emulsify and not wash off when mixed with water.

Effect of Heat—Heat 5 c. c. of oil in test tube over flame until vapors are evolved, and compare color of heated oil with color of unheated oil. If the heated oil turns black it shows the presence of undesirable carbon or hydrocarbons.

Additional tests are made, depending on the purposes for which an oil is to be used. If it is a compound marine-engine oil the name of the fixed oils and the percentage used is determined; the percentage of free acid in the fixed oil is also determined, as all fixed oils contain a certain percentage of free acid, but usually not sufficient to cause corrosion of the journals. A quantitative test for sulphur can also be made by burning the oil in a special lamp. A distillation test has been made to determine the percentage of light and heavy fractions contained in various mineral oils. This test is being continued, using samples of "used" oils.

Physical Constants

The physical characteristics are determined as follows:

Color—The color, although having no influence on the lubricating value, may be used to identify the sample. American oils fluoresce with a grass-green color; Russian oils have a blue sheen; oils containing distillation residues and unfiltered oils are brown to green-black in reflected light. Nearly all mineral machinery oils are distilled and filtered to some extent and are transparent in a test tube, the colors ranging from a yellowish white to a blood red. The color may be determined in a tintometer by comparing with different colored glasses or lenses. These glasses are numbered and for machinery oil extend from a number 1 (white) to number 6 (red).*

Odor—The odor may be determined by heating in a test tube or by rubbing on the hand, by which means fatty oils, coal tar, rosin oils, etc., may be detected.

Specific Gravity—The specific gravity is obtained by the use of the "pyknometer," this term signifying any vessel in which an accurately measured volume of liquid can be weighed. The bottle is first filled with distilled water at a temperature of 60 F., and the weight of the water determined. The bottle is then filled with oil at a temperature of 60 F. and the weight of oil determined. The weight of oil divided by the weight of water gives the specific gravity at 60 F. The Baumé gravity is obtained by using the Baumé hydrometer, which is simply an ordinary hydrometer with a certain arbitrary scale. Baumé gravity may be converted into specific gravity by the following formula:‡

$$\text{Sp. gr.} = \frac{140}{130 + \text{Baumé}}$$

Baumé gravity is largely used in commercial practice.

The specific gravity does not affect the lubricating value of an oil, but indicates to the experienced

* Editor's Note—This is the scale used by the National Petroleum Association.

‡ Editor's Note—The scale in general use in the oil trade is based on the formula $\text{Sp. gr.} = \frac{141.5}{131.5 + \text{Baume}}$

oil man the locality from which the crude oil is obtained. For instance, the specific gravities of the lubricating oils tested at the Experiment Station vary from 0.864 to 0.945. A Baumé gravity of 32 corresponds to a specific gravity of 0.864,† and a Baumé gravity of 18.1 to a specific gravity of 0.945,† so that an increase in specific gravity is a decrease in Baumé gravity. The paraffine base oils of Pennsylvania derivation have an *average* specific gravity of 0.875 with a corresponding Baumé gravity of 30.† The asphaltic base oils from Texas and California have an *average* specific gravity of 0.930 with a corresponding Baumé gravity of 20.†

Figure I (a) shows the pyknometer and (b) a Baumé hydrometer immersed in oil.

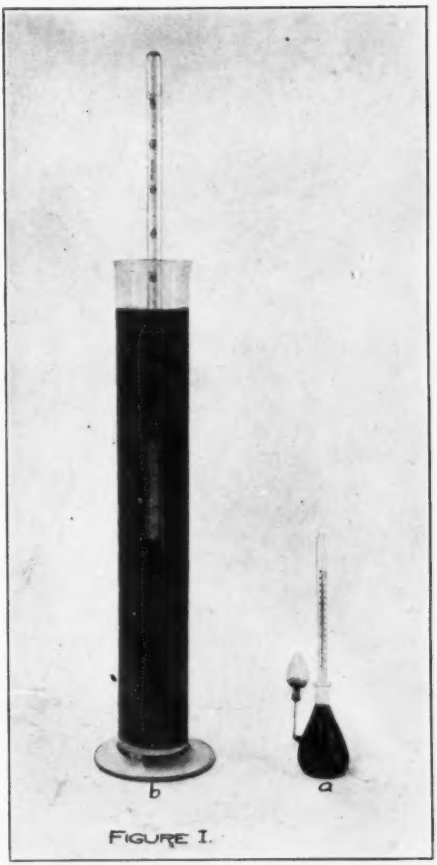


FIGURE I.

Flash Point—The flash point is determined with both the Cleveland open cup (Fig. II, a) and the Pensky-Martin closed cup (Fig.II, b). The flash point of all oils is determined as a measure of the volatility of the oils. The flash point of steam-cylinder oils is of primary importance, the required flash point depending on the temperature of the steam at the engine. With lubricating oils for bearings the flash point is important only in that it indicates the volatility of the oils, and the presence of kerosene or naphtha fractions, with the accompanying fire risks. In the case of very low flash-point lubricating oils it is desirable to run a special distillation or volatility test mentioned under chemical tests. The flash point determined with the open cup is higher than with the closed cup, as the inflammable gases on the surface of the oil are disturbed by the air currents in the open cup. These differences range from 5 degrees to 40 degrees, with the average at 20 degrees. The presence of very light ends (kerosene, naphtha, etc.) may increase this difference to 100 degrees.

Fire Point—This is the temperature at which the oil burns, and is determined by raising the temperature about 3 degrees a minute, applying the flame for about a second. The fire or burning point is from 30 degrees to 65 degrees higher than the flash point with all lubricating oils, the light oils having a difference of about 40 degrees.

† By the formula given above.

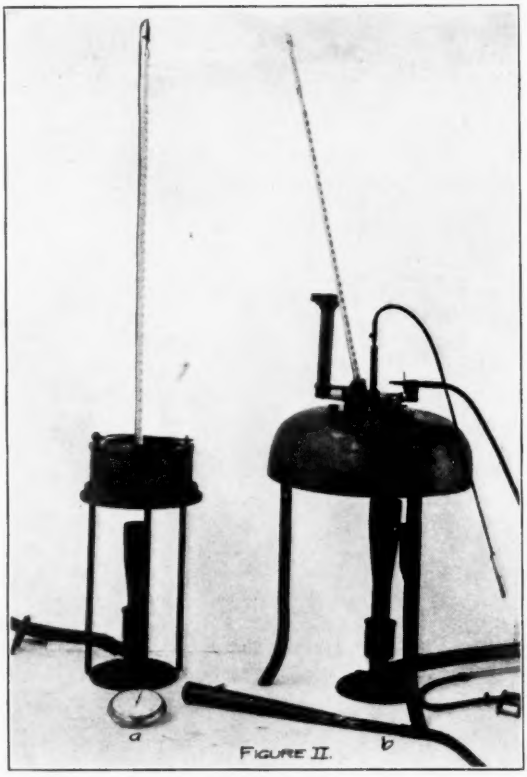


FIGURE II.

Cold Point—Mineral oils become more viscous on cooling, and finally solidify. In lubricating oils refined from paraffine base crudes, cooling first causes the paraffine particles to solidify, which gives the oil a cloudy appearance; with this class of oils this change is known as the cloud point.

The Committee on Lubricants of the American Society for Testing Materials uses the words "cold test" as a general term with sub-heads of "cloud test" and "pour test."

The method recommended by this committee is used at the Experiment Station, and in substance is as follows: Heat the oil to 150 F. and cool by air to 75 F. Take a bottle about 1¼-inch inside diameter and 4 to 5 inches high and pour in oil to a height of 1¼ inches from the bottom. Insert a cold test thermometer (specially made, using colored alcohol, and with a long bulb) through a tight fitting cork. A special jacket is used having an inside diameter about ½ inch larger than the bottle. Ice or any other cooling medium is packed around this jacket. When the oil is near the expected cloud point, at every 2 degrees drop in temperature remove the bottle and inspect the oil, being careful not to disturb the oil. When the lower half becomes opaque, read the thermometer; this reading is taken as the cloud point. The cold or pour test is simply a continuation of the cloud test, except that the temperature is noted every 5 degrees and the bottle tilted till the oil flows. When the oil becomes solid and will not flow, the previous 5 degree point is taken as the cold point of the oil. In the naval service a low cold point is required only on ice machines. All ice-machine oils should have a cold point of minus 15 F., which will permit a brine temperature of minus 20 F. Oils used on motor-boat engines should have zero cold test if the boats are used in cold climates. The lubricating oils refined from asphalt-base crudes, or Southern crudes, have a natural cold point around zero degrees; these oils do not show cloudiness before solidifying. The oils from paraffine-base crudes, or Northern crudes, must be run through the filter presses to squeeze

out the paraffine before a low cold test can be obtained.

Viscosity—The viscosity of a lubricating oil is the most important constant to be determined. The viscosity of an oil is inversely proportional to its fluidity, and is a measure of its internal resistance or resistance to flow. The absolute viscosity is determined from the amounts flowing through capillary tubes, the results being given in C. G. S. units. The determination of the absolute viscosity is a very difficult operation requiring complex apparatus and a relatively long time. Several absolute viscosimeters have been invented; but to date none of them is considered practical enough for the routine testing of oil.

FIGURE III.

There are three well known commercial viscosimeters: The Engler, which is largely used in Europe; the Redwood, which is the English standard; and the Saybolt Standard Universal, which is extensively used in this country. These three viscosimeters have been carefully compared at the Bureau of Standards by Dr. C. A. Waidner, and conversion tables have been prepared. The use of this type (the short capillary-tube type) has several disadvantages, the principal one being that the readings are simply comparative, and have no direct relation to the C. G. S. units of time, mass and length. The accepted theory advanced by Ubhelohde* is that the viscosity (absolute) is directly proportional to the internal friction of the lubricant, and that the viscosity is a direct indication of the friction which will be developed in a bearing. The use of the three commercial types (given above) is therefore allowable, as they will give the relative viscosity and corresponding friction of different oils. The readings of these viscosimeters may be converted to absolute viscosity units by using Ubhelohde's formulas, thus permitting the use of the commercial machines for scientific work, providing the proper corrections are made in regard to gravity and temperature.

Under normal conditions of bearing ubrication the lightest oil that

* The Theory of Lubrication, by L. Ubhelohde, "General Electric Review," November, 1915.

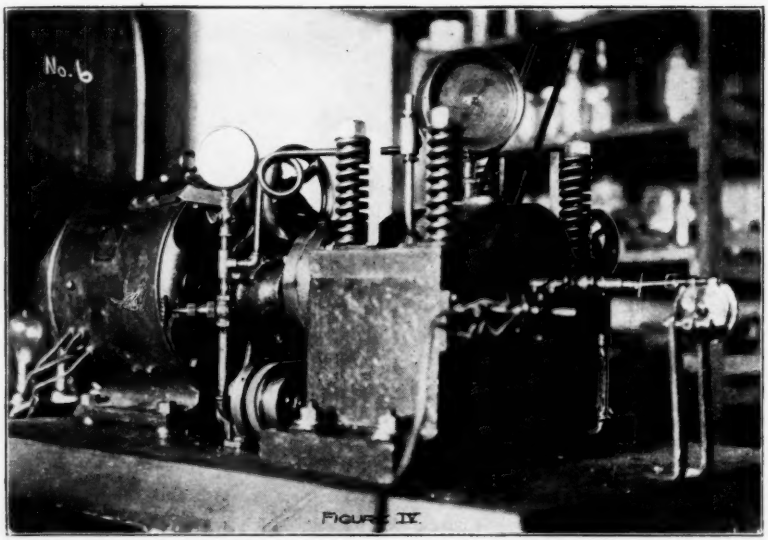


FIGURE IV.

will prevent seizing should be used to obtain a minimum frictional loss.

In Figure III is shown the Saybolt Standard Universal machine. At the Engineering Experiment Station four machines are used, on which very concordant results can be obtained.

Friction Machines—Figure IV shows one of the friction machines designed and used at the Engineering Experiment Station. The machine consists of a hollow-steel journal, one foot in circumference and six inches in length, driven by a variable-speed motor. The bearing is of the usual white metal, and is lubricated by a forced-feed system, consisting of a small geared pump driven by a variable-speed motor; and a drain tank with cooling coils underneath the base of the machine. The load on the bearing is regulated by the calibrated springs shown in the photograph. An electrical heating unit is placed inside the journal so that the temperature of the journal may be varied.

Usually three series of runs are made. The first series is made with a constant speed of 600 revolutions per minute (in this machine also feet per minute), with a constant oil pressure of 15 pounds and with the bearing-cap pressures varying from 30 to 150 pounds per square inch. By measuring the watts input to the armature the co-efficient of friction is obtained, knowing the load, speed, and armature position. The second series consists of runs with a constant bearing-cap pressure of 60 pounds per square inch, an oil pressure of 15 pounds, and speeds varying from 600 to 1,800 revolutions per minute. The third series consists of runs made with a constant bearing-cap pressure of 60 pounds per square inch, a constant speed of 600 revolutions per minute, an oil pressure of 15 pounds, and with varying bearing temperatures obtained by using the heating unit.

These tests are comparative only; the results being simply the friction obtained by using various oils on this *particular* bearing. Tests have been made which show

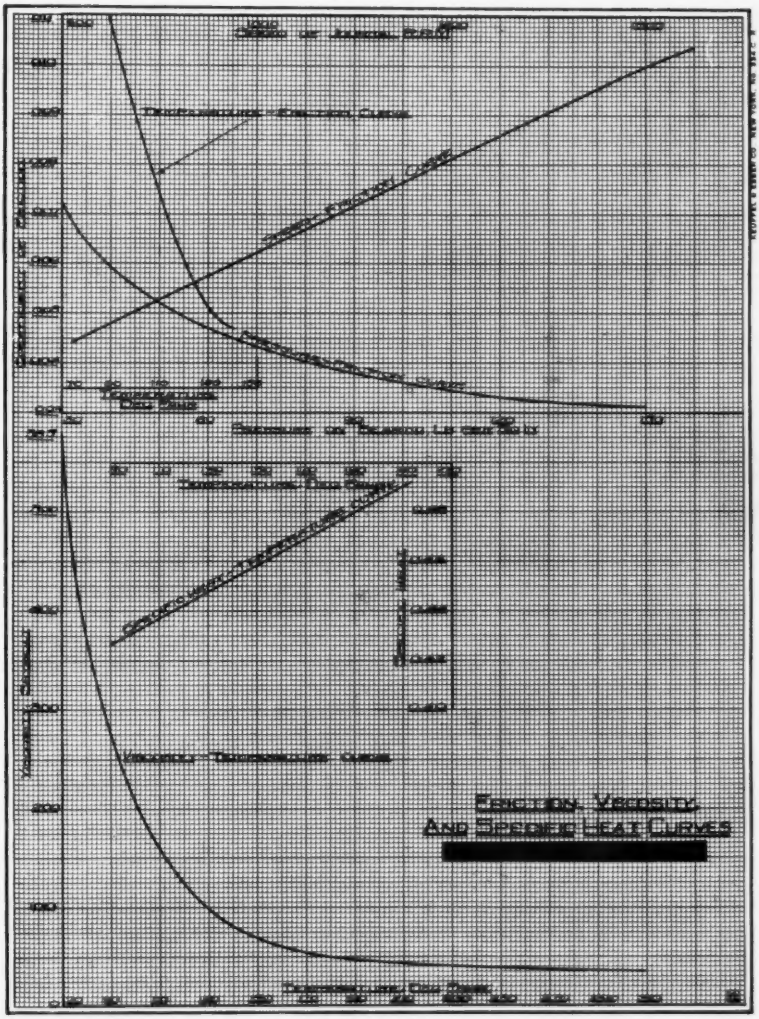
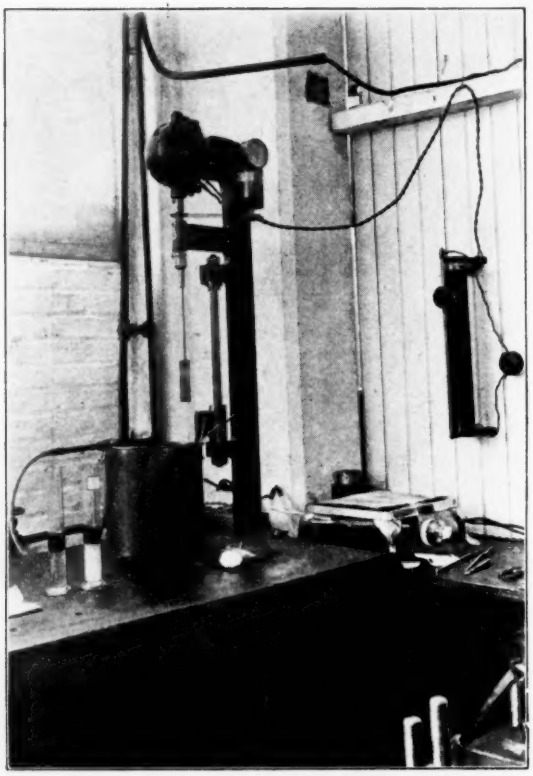


Figure V.

that the friction is directly proportional to the viscosity of the oil at the temperature of the bearing.

Figure V shows the three friction curves for the various runs made on a light oil. This figure also contains viscosity and specific heat curves for this oil.

Emulsion Tests—Emulsion tests are made on a machine designed by Lieutenant G. S. Bryan, U. S. Navy. An improved type is shown in Figure VI. The method of conducting the test is described in the memorandum quoted at the beginning of this article. The emulsion is made with distilled water, as there is always a possibility of fresh water getting in the system



on board ship. Salt water is also used, as the oil coolers often leak, and in submarines the engine-cooling water seeps into the oil system. Normal caustic soda solution is taken, as there is a possibility of water containing boiler compound getting into the system. Boiling distilled water is used in case gland steam from turbines, or steam leaking by the piston-rod packing on reciprocating engines having forced lubrication, runs into the oil system.

These emulsion tests are considered of the greatest importance, as an oil to be used satisfactorily on any type of forced lubrication system must not emulsify. If emulsions do occur it will mean clogging of the oil lines, forming of residues in the base of the bearings, with a resultant loss of a large amount of oil. In the examination of *used* oils received from cruising ships, very often an emulsion consisting of a large percentage of salt water, oil, salt (NaCl), iron oxide (rust) and dirt will be found. The oil *before use* will not show an emulsion when stirred with salt water, but in the *used* oil the large percentage of salt water becomes mixed with the oil and they are held together by the particles of rust and dirt. There is no *practical* method by which this residue or emulsion can be broken up and the oil recovered.

At present the only oil used on board ship which is required to emulsify with water is the oil for engines having wick-feed lubrication. To date an oil mixture composed of from 80 to 90 per cent mineral oil and from 10 to 20 per cent animal or vegetable oil (rape oil, tallow oil, etc.) has been used for wick-feed lubrication. This fixed oil (animal or vegetable) will form a heavy, soapy emulsion when mixed with water, thus preventing the oil from being washed out when the water is turned on the outside of the bearing. Tests have been made at the Engineering Experiment Station and on board ship in an endeavor to find out whether or not this compounded oil may be replaced with a straight mineral oil. The preliminary results of these tests have been very satisfactory, and, if borne out by further tests, will eliminate all fixed oils from use on board ship.

Practical Tests—All oils submitted for forced-lubrication purposes are given a working test on the Experiment Station 75-kw. turbo-generator for 100 hours, with the generator running at 2,400 revolutions per minute. The oil is placed in the main bearing, which has ring-feed lubrication. A careful record is made of the temperatures and of the amount of oil required to keep the reservoir full. After the test the bearing and journal are carefully examined; the oil is taken out from the various sections of the system, analyzed and tested. Naturally a bearing of this type calls for a very light oil to give the best results. Nevertheless, all kinds of oils are tested on this bearing without resulting in any serious damage. From the examination after use in the turbine, the action of this oil in service can be predicted as far as its lubricating value is concerned.

Service Tests—These tests are made on board ship. The oil to be tested is usually sent to a ship which has been using an oil which has proven satisfactory, and which has practically the same characteristics as the oil to be tested. This test extends over a period of several months, and should be prolonged for at least 500 hours of steaming. During the test the following data should be taken in order that the results may be properly interpreted:

Amount, in gallons, of oil put in system at beginning of test, and amount put in during test.

Maximum and average temperatures obtained on bearings during test.

Maximum and average temperature of oil entering the system.

Average pressure carried on lubricating-oil pumps.

Volume of oil passing through system at average cruising speed, in gallons per hour.

Amount of oil boiled out, and the loss due to this boiling out; also, temperature at which oil is boiled out.

Condition of bearings, tanks, and oil-feed lines after test.

Number of hours of steaming while oil was under test.

If, as is usually done, the oil to be tested is placed in the lubricating system of one engine room and the oil regularly used in the system of the other engine room the above data should be taken for both oils. After the test a 5-gallon sample of the new oil before use in the system, and a 5-gallon sample of the oil *after use* in the system, are forwarded to the Experiment Station for examination and test. This is done to insure that the oil furnished for service test is the same as the oil originally supplied to the station for preliminary test; also, for the purpose of studying the *used* oils.

Special Tests—Due to the relatively small amount of information obtainable on the action of lubricants in service, it is necessary to continually develop new tests in order that the various new types of machinery may be properly lubricated.

At present the study of oils after several hundred hours use in service is being made. Particular attention is being paid to the loss of oil by vaporization or volatilization, and the resulting characteristics of the remaining oil in the system.

One test on the "Fractional Distillation of Lubricating Oils" was described by one of the Experiment Station chemists, Mr. J. G. O'Neill, in the May, 1915, issue of the Journal of the American Society of Naval Engineers. Fur-

ther tests along this line are being made in an endeavor to find out the percentage loss after use in service of the various kinds of lubricants.

Tests are being made to determine the cause of emulsions, and methods of preventing this very undesirable condition.

Tests for carbon deposits in internal combustion engines have been made with various oils, but the results are not sufficiently conclusive for publication.*

A number of compounds have been tested which are supposed, when mixed with gasoline, to give increased power and speed, reduced carbon deposits and, at the same time, give efficient cylinder lubrication. The tests on these substances to date have not been wholly satisfactory.

Determination of the specific heat of various oils has been made in connection with oil-cooler tests. Also a test to determine the rate of flow through pipes will be made very shortly; the results to be used in the design of oil coolers and oil-feed piping.

At the present time it is a comparatively easy matter to obtain satisfactory oils for bearing lubrication by the employment of the tests above enumerated. From the large amount of data accumulated at the Experiment Station, whether or not an oil will prove satisfactory can be closely predicted by a consideration of the results obtained on the preliminary tests. New mechanical features requiring new standards of lubrication are always coming up, which necessitate new tests. The lubrication of the high-speed reduction gears and the efficient cooling of Diesel engine pistons are two of the problems now requiring solution, which will undoubtedly be solved by making careful chemical, physical and practical tests of the various lubricants to be used, in connection with a study of the method of applying the lubricant.

The tests described in this article have to a considerable extent been directly responsible for the present efficient lubrication of naval machinery, and a continued study will surely result in more efficient lubrication and in a great reduction in the amount of oil used per horse-power developed.

TEXACO PRODUCTS IN THE UNITED STATES NAVY

By Frank J. Shipman

The Texas Company bid on the Navy business as far back as 1908, but up to the year 1911, with no success, the apparent reason being a prejudice against the use of any oils made from other than Northern crudes. During the latter part of 1910, however, the Navy Department was experiencing considerable trouble lubricating the battleship "DELAWARE," which had just been placed in commission. This battleship was the first to be fitted with a forced feed lubricating system, and it was found that an oil light in viscosity, such as was then being used in the Navy, could not be satisfactorily used.

* Editor's Note—See the article by Lieut. G. S. Bryan, "Motor Cylinder Lubrication," in the *Journal of the American Society of Naval Engineers*, Vol. XXVII, No. 1, Feb., 1915. The editor will be glad to send a reprint of this article upon request.

The Texas Company was called upon to furnish an oil, and submitted TEXACO CIRCULATION OIL HEAVY, which is now called TEXACO URSA OIL. The "DELAWARE" used this oil very successfully, steaming 54,627 miles the first two years without a single hot bearing or pin.* From that time to the present the Texas Company has had a Naval contract each year.

It is the natural assumption of those who are not familiar with the Naval lubricating oil contract that all that is necessary to secure the Navy business is to be the lowest bidder. The article by Lieut. Kauffman, published in this issue, indicates at once how far this is from the truth. Even though the oils pass through the rigid series of tests described in Lieut. Kauffman's article, the successful contractor must then guarantee each and every shipment of oil to be suitable for the purpose intended, and to be entirely satisfactory. During the year that deliveries are made under contract, the various oils are checked and the contractor is held to a strict accountability as to supplying an oil identical to that which was furnished for test. Moreover, the contractor is required to make deliveries, if necessary, within twenty-four hours, aboard a battleship at any Navy Yard or Naval Station or in the harbors.

Each year the Navy Department awards the Engineering Pennant for efficiency in engineering, and as the consumption of oil is an important factor, the engineering force aboard all vessels work very hard to economize in the use of oil and win this distinction for their ship. During the year 1913-14, the Pennant was won by the battleship "KANSAS" using TEXACO DOLPHIN OIL, and during the fiscal year 1914-15, was won by the "NEBRASKA" using TEXACO NEPTUNE OIL. Our other oils were contributing factors towards winning these marks of merit, as they were used for the auxiliaries of the vessels named.

The oils for the lubrication of a battleship must necessarily be the finest products that can be obtained, as a battleship is virtually a small city, at times completely isolated, and housing approximately 1000 men. There is the central power plant or main engines of 180,000 h. p. in the new ships, and many auxiliaries, such as the ice machines, electric generators, innumerable pumps, deck machinery, hoisting apparatus, pneumatic apparatus for operating the turrets, and the like. Of course the main engine oil, whether it be for a turbine ship or a reciprocating engine ship on wick or forced feed, is the most important. The ice plant or cooling plant aboard a battleship is also a very important factor, as it is necessary to keep large quantities of perishable food in cold storage. They also have an elaborate apparatus for cooling the magazines, it being necessary to keep the munitions cool at all times.

Referring to the contract for the fiscal year, 1915-1916, TEXACO oils were used not only on Naval vessels and at the Navy Yards on the Atlantic coast, but also practically all over the world at our government Naval Stations and by our Naval vessels. The Texas Company was awarded all

* See the article by Capt. C. W. Dyson, U. S. N., "Engineering Progress in the U. S. Navy," in *Transactions of the Society of Naval Architects and Marine Engineers*, Vol. 20, 1912, p. 56.

of the business at Atlantic ports with the exception of two items; at Pacific ports all items with the exception of one; at Oriental ports all items but one; also all items at Havana, Guantanamo, San Juan, Colon, Panama, Trinidad, Buenos Aires and Honolulu, During this year, The Texas Company delivered to the United States Navy approximately one million gallons of high grade lubricating oil, this being about 99¼ per cent of the total requirements.

The kinds of oil which The Texas Company now furnishes are very small in number considering the great variety of machinery to be lubricated. In the Contract Bulletin No. 12 on "Lubricating Oils," issued by the Navy Department Bureau of Supplies and Accounts, for the fiscal year 1917, the following information is given concerning the seven oils covered by the contract of The Texas Company:

"Item 1. TEXACO NEPTUNE MARINE ENGINE OIL—This is a compounded oil, made to saponify with water, for lubrication of reciprocating main engines and auxiliaries where oiling is done by hand or through wick feed or drop oilers, also thrust bearings. This oil is not suitable, nor intended, for other purposes.

"Item 2. TEXACO PINNACLE MINERAL CYLINDER OIL—Viscosity of 130 at 210° F. A heavy mineral cylinder oil possessing fine lubricating qualities, for use on piston and valve rods; can be used under all conditions of steam.

"Item 3—TEXACO SPICA OIL—Viscosity of 100 at 100° F.; cold test 5° below zero F. For lubrication of the compressor and expander cylinders of ice machines and for pneumatic tools. It is light in body and color; can be used in hydraulic systems; also for cleaning small arms. Will not gum or corrode.

"Item 4. TEXACO ALGOL OIL—A heavy oil. This is a straight mineral oil, has a viscosity of 500 at 100° F.; cold test 5° F.; will not saponify or mix with water; recommended for lubrication of internal combustion engines of motor boats, submarines, and aeroplanes; also for lubrication of main engines on forced feed, for turbines of heaviest type; on torpedo-boat destroyers having a combination of turbines and reciprocating engines.

"Item 5. TEXACO ALCAID OIL—A medium oil. Viscosity of 300 at 100° F., zero degree F., cold test. An excellent turbine and forced lubrication oil if an oil of this viscosity is desired. For lubrication of internal combustion engines of motor boats, submarines and aeroplanes, also torpedo air compressor cylinders and bearings.

"Item 6. TEXACO CETUS OIL—A light oil. Viscosity of 200 at 100° F.; zero degree F., cold test. For turbines, dynamos, Diesel engines, and for use on motors where a light viscosity oil is desired, and for general oil about ship.

"Item 4b—TEXACO URSA OIL—An extra heavy oil. This is a straight mineral oil, has a viscosity of 750 at 100° F.; cold test, 5° F.; recommended for lubrication of large internal combustion engines of motor boats, submarines and aeroplanes, also for lubrication of main engines on forced feed, for turbines of heaviest type; or torpedo-boat destroyers having a combination of turbines and reciprocating engines; also Diesel engine cylinders, air compressors, and bearings."

The fine work accomplished by TEXACO lubricating oils, not only in the Navy, but elsewhere, has almost entirely overcome the prejudice which formerly existed against lubricants manufactured from Western and Southwestern crudes, as is indicated by the fact that one of the competitors of The Texas Company recently came out in a "House Journal" with the frank statement that they had been furnishing asphaltic base oils to their customers for years, but had not advised them to this effect, because of the fact that the public had theretofore been so prejudiced against these oils, the article further stating that as it was generally becoming recognized that asphaltic base oils were superior to paraffine base oils for general lubricating work, the writer considered it high time to advise the public that all the oils his company was marketing were made from asphaltic base crudes.

Reg. U. S. Pat. Off.

Vol. I. December, 1911 No. 2

Lubrication

CONTENTS

Editorial

Losses Caused by Inadequate Filtering Systems

Conditions Where Lubrication has been Impossible

A Change in the Rule of Lubrication

Two Very Difficult Bearings to Lubricate

Practical Troubles Remedied

An Unusual Condition in Hydraulic Pump Work

Published Quarterly by
The Texas Company
New York

Vol. I. March, 1912 No. 3

Lubrication

In this number we publish two articles, viz.:

"Oil Grooves in Bearings"
and
"Specifications."

We consider both of these articles of sufficient importance to publish them in their entirety even at the cost of crowding out other matters.

Published Quarterly by
The Texas Company
New York

VOA

Vol. 1 JUNE, 1912 No. 4

Lubrication

CONTENTS

Editorial

Motor Lubrication with
Some Side Lights
on Compression
and Carbon

Changes in Lubrication
Required

Published Quarterly by
The Texas Company
New York

Vol. 1 OCTOBER, 1912 No. 5

JUL 23 1913

Lubrication

CONTENTS

Editorial

Lubrication of Electric Railway Motor Axles

Circulating Feed Systems

A Comparative Test

Published Quarterly by
The Texas Company
New York

Vol. 1 FEBRUARY, 1913 No. 6

MAR 10 1913

Lubrication

Special Motor Number

CONTENTS

Editorial

Carburetor Adjustments

An Interesting and Conclusive Test on Texaco Motor Oil

A Report on Gasoline Testing

Instruments for Motor Testing

The Gasoline Shortage

Published Quarterly by
The Texas Company
New York

Vol. 1 MAY, 1913 No. 7

Lubrication

CONTENTS

Editorial

"Economic Use of Lubricating Oils"

Otto Gas Engine Belted to a Yorke Ice Machine

Texaco Ursa Oil

Texaco on the Railroad

Published Quarterly by
The Texas Company
New York

Vol. 1 OCTOBER, 1913 No. 8

OCT 30 1913

Lubrication

CONTENTS

Editorial

Texaco Crater Compound

Developments in Lubrication

Test on a Hamilton Cross Compound Engine

Steamship "Texas"

Long Time Runs

Published Quarterly by
The Texas Company
New York

Vol. II JULY, 1914 No. 2

Lubrication

CONTENTS

United States Navy Awards

Good Lubrication—The Motor Conserver

Lubrication

The Effect of Mixing Oils

Motor Efficiency

Cylinder Lubrication

Airboat "America"

Published Quarterly by
The Texas Company
New York

Vol. II NOVEMBER, 1914 No. 3

NOV 30 1914

Lubrication

Power Plant Number

CONTENTS

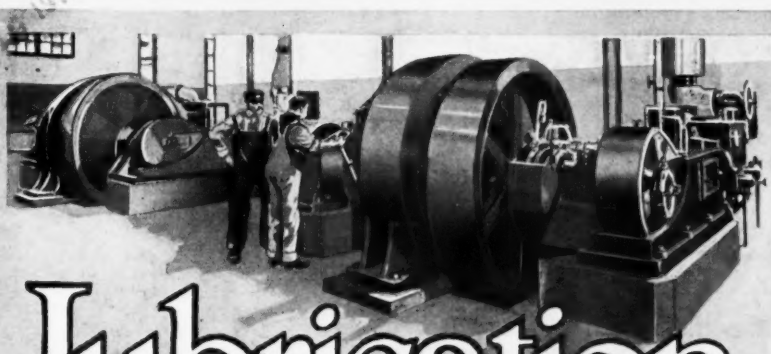
Power Plant Lubricating Efficiency

Effects of Continuous Use upon an Oil

Long Turbine Runs with Texaco Oils

Properties of Saturated Steam (Table)

Published Quarterly by
The Texas Company
New York



Lubrication

FEBRUARY, 1916

Vol. III No. 4

CONTENTS

The McIntosh & Seymour Diesel Type Oil Engine
By John W. Martin

Temperature Considerations in Oil Testing
and
Sundry Items About
TEXACO CRATER COMPOUND

Published by
THE TEXAS COMPANY
New York

It Could Not Be Done Before — But TEXACO CRATER COMPOUND Did It

RECENTLY we had occasion to observe TEXACO CRATER COMPOUND at work in a large Iron Works in Ohio. Our inspection led us to a large Plate Mill. Here the bevel gears and the roller bearing shaft on the tilting tables and the approach table were lubricated with TEXACO CRATER COMPOUND.

Water and salt were thrown onto the hot plate to cool the rolls and break the scale.

There never was a lubricant that could live under the combined onslaughts of pressure, radiated heat, water and salt. There never was—till TEXACO CRATER COMPOUND came along.

There are many places where gears or bearings are exposed to high heat, to the elements, to blast furnace fumes, or to water. These places can be lubricated or protected with TEXACO CRATER COMPOUND.

TEXACO CRATER COMPOUND also lubricates and protects wire rope, exposed to heat, gases, acid, or moisture.

Practically all of the largest wire rope manufacturers will lay up your ropes in TEXACO CRATER COMPOUND if you so specify. Your wire ropes will last longer if so made, and later treated with TEXACO CRATER COMPOUND.

THE TEXAS COMPANY

HOUSTON NEW YORK

DISTRIBUTING POINTS IN PRINCIPAL CITIES

RAND McNALLY & CO., NEW YORK

Lubrication

MARCH, 1916

Vol. III No. 5

THE SNOW OIL ENGINE

COLD TEST AS APPLIED TO LUBRICATING OILS

Published by
THE TEXAS COMPANY
New York

THIS IS "CRATER"

SKETCHED FROM PHOTO

HE is one of our prize heavy draft horses in Chicago. The boys out there named him after TEXACO CRATER COMPOUND—the great gear and rope lubricant.

They gave him this name in recognition of his strength and his capacity for hard work.

They felt for this handsome animal the same pride which the whole organization takes in the success of

TEXACO CRATER COMPOUND

The reader may think it a little strange for a business organization to show such enthusiasm for a lubricant.

That's just the point—

TEXACO CRATER COMPOUND is NOT an ordinary lubricant.

It is doing things in the way of lubricating which could not be done before.

It saves gears by giving effective lubrication, under conditions where no product formerly employed could remain a lubricant.

We have daily reports on the performance of TEXACO CRATER COMPOUND which, when judged by old standards, seem almost impossible.

Here's a rolling-mill man who shows us gears on a roll table train, with a perfect coating of TEXACO CRATER COMPOUND, despite the high radiated heat.

Here's a cement man who tells us how TEXACO CRATER COMPOUND saves his gears in the face of heat, enormous pressure and flying dust.

Here's a coal operator, who tells of "Crater's" resistance to mine water—and the protection it gives to wire rope.

On wire rope, clients tell us they now measure the life of a rope in months—where formerly the same number of weeks meant wear, corrosion and destruction.

TEXACO

There is one point about TEXACO CRATER COMPOUND we want to make as strong as possible. IT IS pure lubricant.

There is nothing in it which separates out—hardens, or which can be affected chemically. That's why it's such a great lubricant—and that's why

TEXACO

IT SAVES THE GEARS

THE TEXAS COMPANY

1915

Lubrication

APRIL, 1916

Vol. III No. 6

THE SOUTHWARK-HARRIS DIESEL ENGINE

"INSIDE THE ROPE"

"GOOD LUBRICATION AND ECONOMY ON A GAS ENGINE"

Published by
THE TEXAS COMPANY
New York

THE MODERN ENGINEER is a regular "Old Sleuth" —ever on the trail of power thieves.

Today he traces a loss of B. T. U. to a cracked boiler setting—the day before he has convicted loose belts of stealing power—

Tomorrow it may be a leaky valve which he finds robbing him of steam.

In his crusade against lost power the engineer has valuable deputies in

TEXACO LUBRICANTS

They stand by him in his efforts to rid the whole plant of friction—the unseen thief of power.

You can put TEXACO LUBRICANTS to work from cellar to roof, from the coal conveyors to the electric fan on the president's desk.

Wherever they go, they reduce friction, save wear and decrease costs. They do this because each TEXACO LUBRICANT is carefully made for a specific purpose, and has been thoroughly tested for that purpose.

TEXACO Service is complete. We can supply you with the right lubricant for any place whatever—whether it be engine, machine, dynamo—whether for use on shafting, belts, gears and pinions, or for hoists and elevators.

Give us the opportunity to put TEXACO LUBRICANTS in your plant. The record they make will keep them there.

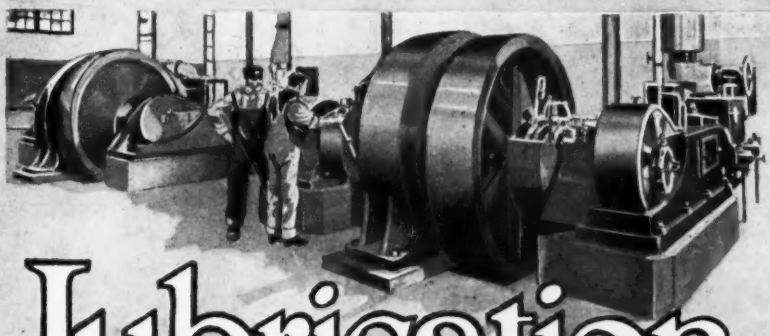
THE TEXAS COMPANY

17 Battery Place, New York

HOUSTON - - NEW YORK

BRANCH OFFICES:

Boston Philadelphia Chicago Norfolk
Atlanta Birmingham New Orleans Dallas
Denver Oklahoma City El Paso
St. Louis Youngstown



Lubrication

MAY, 1916

Vol. III No. 7

CONTENTS

The Right Lubrication After Fifteen Years

Diesel Engine Lubrication
Based on a Report by J. L. Wilson, Engineer, The Texas Company, Philadelphia

Wire Rope Lubrication
By Geo. R. Rowland, Supervising Engineer The Texas Company

Lubricating the Low Pressure Through the High

Published by
THE TEXAS COMPANY
New York

LUBRICATING *the* DIESEL ENGINE

Because of the mechanical conditions involved, and the wide range of conditions that must be met, the selection of the proper lubricant for the Diesel Engine is of paramount importance.

The engineers of the Texas Company have had an enviable opportunity for the study of the Diesel Engine, in this country, as well as abroad.

We have developed in

TEXACO URSA OIL

a lubricant of unusual suitability for this class of work, this one oil taking care of the lubrication of the power cylinders, air compressor, and the general lubrication of the machine.

TEXACO URSA OIL is an exceptionally rich product, with excellent body, and can be used with great economy.

It is unusually low in carbon content, high in boiling point, and low in flash, three essential qualifications for internal combustion engines.

Altogether, it is a product admirably suited for Diesels of all types—and many of the leading manufacturers have welcomed the opportunity of being able to advise the use of an oil so thoroughly suited to their engines.

We will be glad to furnish any further information on TEXACO URSA OIL or any lubricant you may require.

THE TEXAS COMPANY

Department "H.I.", 17 Battery Place, New York

HOUSTON - - NEW YORK

BRANCH OFFICES:

Boston Philadelphia Chicago Norfolk
Atlanta Birmingham New Orleans Dallas
Denver Oklahoma City El Paso
St. Louis Youngstown

Lubrication

JUNE, 1916

Vol. III No. 8

IN this number we are running an article entitled "Oil Grooves in Bearings," by Mr. C. N. Scott.

This article appeared in an early number of LUBRICATION. There have been so many requests for copies of this, that we deem a reprint to be in order.

The subject is of paramount importance and the demand has been so insistent that we are willingly allowing this article to crowd out other matter from this issue of LUBRICATION.

Published by
THE TEXAS COMPANY
New York

AMERICAN MANGANESE STEEL CO.

GENERAL OFFICES
EASTERN SALES OFFICE
ACCOUNTING DEPARTMENT
FOUNDRIES
CABLE ADDRESS "EAMSCO"

CHICAGO, ILL. May 5, 1916

The Texas Company,

Chicago, Illinois.

Gentlemen:

In replying to your request for my opinion on Crater Compound, I am pleased to advise that in many of the mills that are using American Manganese Steel blooming mill pinions your Crater Compound is being used with such satisfactory results that I believe if a frictional test should be made they would find a marked reduction in load on their engine. Smooth starting and stopping is effected on gears upon which your Crater Compound has been applied, and I also note that they are quieter.

Trusting that this information may be of value to you, I beg to remain

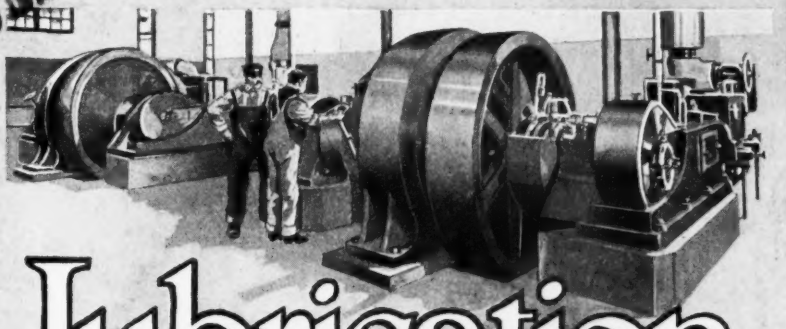
Yours very truly,

E. S. Black.

ESB-b

(MR. BLACK IS A RECOGNIZED AUTHORITY ON GEARS)

Tech.



Lubrication

JULY, 1916

Vol. III No. 9

CONTENTS

Efficient Hydro-Electric Plant Lubrication
By O. J. May, Chief Engineer, Chicago District, Texas Company

A Letter to Uncle Bill

The Salesman's Story
By S. S. Jackman

Published by
THE TEXAS COMPANY
New York

I Crawled Into the Tunnel—

Down in the semi-darkness, I could see almost endless rows of huge bevel gears revolving rapidly.

Overhead through the concrete floor we could hear the rattle and bang of the wire and rod mill machinery.

Yet down here it was comparatively quiet, and I didn't have to strain my ears to hear the Superintendent. He had invited me down to the tunnel to see

TEXACO CRATER COMPOUND

at work on the bevel gears and pinions.

He said, "Only last month you couldn't stay here on account of the deafening noise of the gears. You'd think your ear drums would burst. Now, it's so quiet I hardly know the place. We put on some of your Crater Compound. It stopped the noise—and I don't have to tell you that that noise means wear."
He explained that these gears were difficult to lubricate because of their form, their inaccessibility, and because they were running right up to the limit speed.

He said, "Dirt and scale sift down through the jack shaft opening, but I find that CRATER sticks to the teeth and is saving the gears."

This Superintendent appreciates the value of gear lubrication. He said, "I had the crew go down into the tunnel twice a day to lubricate the gears. Since using CRATER I send them down as often as before for safety, but we find that the gears are no longer dry when the men get to them."

Interviews like this are gratifying. We meet them again and again.

Practical men are elated over finding a product which so adequately meets the difficult operating conditions. We always find them generous in their praise for a really good product.

A trial of CRATER on your gears will show such excellent results that you will talk like this Superintendent. Tell us about your gears, and the conditions under which they are operating. We will tell you how much CRATER to order for a thorough test.

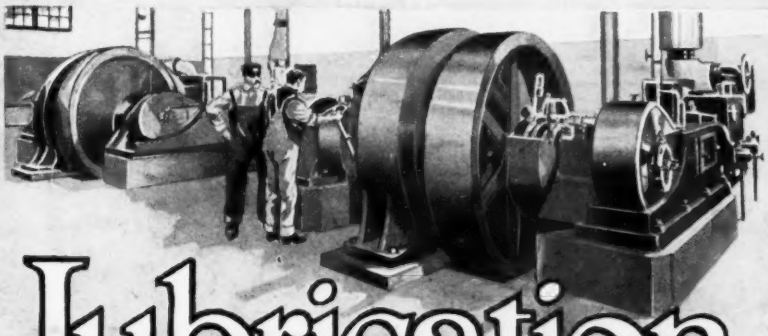
THE TEXAS COMPANY

DEPT. H, 17 BATTERY PLACE, N. Y.

HOUSTON :: :: NEW YORK

BRANCH OFFICES

ATLANTA DALLAS CHICAGO
NORFOLK BIRMINGHAM NEW ORLEANS



Lubrication

AUGUST, 1916

Vol. III No. 10

CONTENTS

Lubrication of Steam Turbines
By W. F. Parish

Ice Machine Lubrication

Motor Oil Efficiency

Salesmen's Stories

A Day with the Engineers

Published by
THE TEXAS COMPANY
New York

"URSA" IS THE OIL

This was the dictum of an Erecting Engineer from a large Diesel Engine Manufacturing Plant after checking up a field test on

TEXACO URSA OIL

And, incidentally, he is by no means alone in his conviction that TEXACO URSA OIL is THE oil for Diesel Engines. Several of the larger manufacturers recommend it with the utmost confidence.

While this engineer was greatly pleased with the oil economy, the cool bearings and the absence of troublesome deposits, the thing which aroused his enthusiasm was the fact that URSA lubricates the ENTIRE unit. It takes care of the lubricating requirements of the power cylinders, air compressors and all other parts.

ONE OIL FOR ALL

TEXACO URSA OIL is a rich lubricant, and of such a uniform nature that it does not distill or decompose in the cylinders. When this oil works past the piston into the combustion chamber, it BURNS CLEAN. You never find carbon troubles where URSA is used.

URSA is one of the carefully prepared lubricants made by The Texas Company. Each Texaco Lubricant is designed to meet a certain set of mechanical conditions, and each one is the right oil for the purpose. We will be pleased at all times to give further particulars and prices.

THE TEXAS COMPANY

DEPT. H, 17 BATTERY PLACE, N. Y.

HOUSTON :: :: NEW YORK

SEP 15 1916

Lubrication

SEPTEMBER, 1916

Vol. III No. 11

CONTENTS

Turbine Oil Filtering Systems
By Edwin M. May

The Muncie Oil Engine
By O. G. Deane

Test of Lubricating Oils for Semi-Diesel Engines
By O. J. May

Electric Crane Lubrication
By S. C. Eberhardt

Published by
THE TEXAS COMPANY
New York

"She Starts Easier With Ursa"

A FREQUENT observation made by operators of Diesel Engines after putting in TEXACO URSA OIL is that there seems to be no difficulty on starting. The explanation of this gives one of the reasons for the unparalleled success of

TEXACO URSA OIL

on Diesel and other Heavy Oil Engines.

Briefly, URSA is a clean, rich, lubricant. It maintains a strong film of oil between the bearing surfaces. That film means lubrication immediately on starting.

We have frequently seen cases where Diesels have been opened after standing idle for a month or more, and upon examining the cylinders and bearings found the film of URSA was still intact.

Also, the rings could be moved freely in their grooves, showing how thorough and lasting URSA lubrication is. The high heat of the Diesel Cylinder (which persists for some time after stopping) evaporates an oil with less staying power than URSA.

A further aid to smooth operation is the entire absence of hard carbon or gummy deposits when URSA is used.

URSA is a bright, clean, homogeneous oil. It does not distill or decompose in the combustion chamber. It burns clean.

One feature of URSA OIL which must appeal to the practical man is that TEXACO URSA OIL takes care of all the parts. It lubricates the power cylinders, the air compressors and all the bearings—ONE OIL FOR ALL. This means efficiency. You use less oil. You are free from the danger of admixture or use of the wrong oil. You get the same high grade of lubrication in ALL places at ALL times.

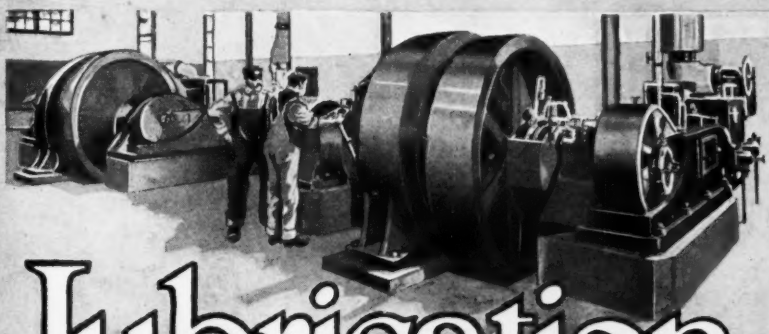
We are glad at all times to supply prices and further information on TEXACO URSA OIL or any lubricant for any purpose whatever.

THE TEXAS COMPANY

DEPARTMENT H

17 BATTERY PLACE - NEW YORK CITY

HOUSTON CHICAGO NEW YORK



Lubrication

OCTOBER, 1916

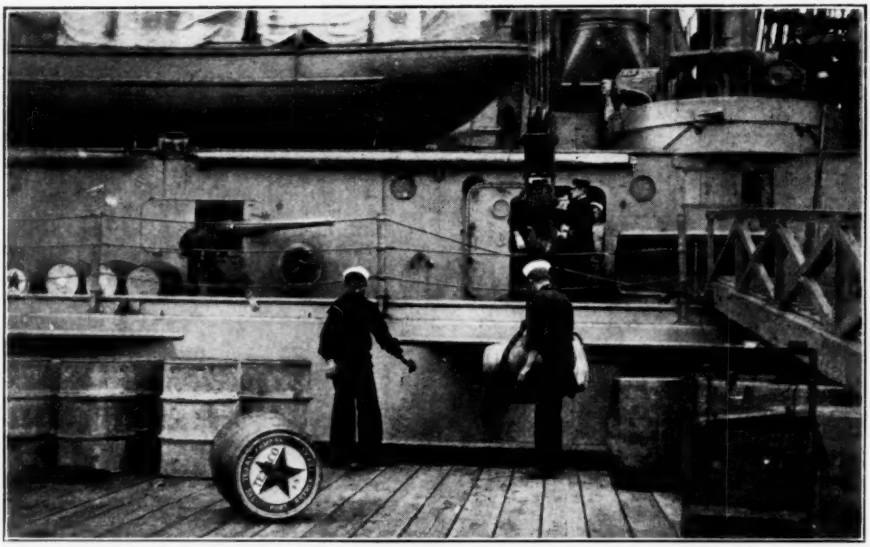
Vol. III No. 12

CONTENTS

Lubricating Oils
The Examination, Laboratory and Practical Methods of Testing
By Lieut. J. L. Kauffman, U. S. Navy

Texaco Products in the United States Navy
By Frank J. Shipman

Published by
THE TEXAS COMPANY
New York



SELLING OILS TO THE NAVY

THE Navy is noted for its exacting purchasing.

Acceptance for use in the Service is equivalent to acceptance as a standard.

Our large business in supplying lubricating oils to the Navy proves their

Quality :: Uniformity :: Service

Some of the TEXACO LUBRICANTS used by the Navy are:

TEXACO NEPTUNE MARINE CYLINDER OIL

For use on main engines and auxiliaries.

TEXACO SPICA OIL

For ice machines, pneumatic tools, for cleaning small arms and for other purposes.

TEXACO URSA OIL

A fine heavy lubricant for heavy turbines, and for gasoline engines; for Diesel engine cylinders, air compressors and bearings; for forced feed systems of reciprocating engines.

TEXACO CETUS OIL

For turbines and dynamos, and for general oil about ship

There are several other oils which have earned high regard for their efficiency and economy. Our ability to meet the high standard set by the Navy and to cover the various conditions, is paralleled by the work we are doing in thousands of power plants and industrial enterprises throughout the country.

We have an oil for every purpose. State your need, and we will be glad to cooperate with you to do the supplying of the right lubricant for your particular requirement. Call on us at any time for information regarding the kind of oil to use on any engine, machine, or dynamo. Our experience is at your service.

THE TEXAS COMPANY

When This Big Diesel Was Dismantled for Shipment

RECENTLY we witnessed a most convincing demonstration of the value of TEXACO URSA OIL for Diesel engines.

A 2500 H. P. Marine Diesel engine had completed a rigorous block test. It was then left standing for more than a month before dismantling for shipment. Our experts were present as it was being taken down, and several instances served to bring home the extraordinary value of

TEXACO URSA OIL

for this class of work. The cylinder walls were in perfect condition, without a trace of carbon. The walls were so well coated with Ursa Oil that the pistons were extracted with the greatest ease, the rings moved freely in the grooves, and there was no carbon whatever on any part of the pistons. You can realize after this report why URSA lubricated Diesels always start without stress or labor.

This clean, perfect and lasting lubrication of cylinders, rings and bearings is but one of the reasons why so many manufacturers of Diesel and other heavy oil engines regard URSA as a "find"—why they are more than pleased to recommend it for use on their engines.

But the real clinching argument for TEXACO URSA OIL on your engine is the fact that TEXACO URSA OIL TAKES CARE OF ALL THE PARTS—ONE OIL FOR ALL. It lubricates the power cylinders and air compressors and all the bearings.

This means efficiency. Less oil is required and freedom from the danger of admixture or use of wrong oil is insured. The same high grade lubrication is maintained in all places at all times. Remember also that Ursa does not distill or decompose in the combustion chamber. It burns clean and never deposits hard carbon.

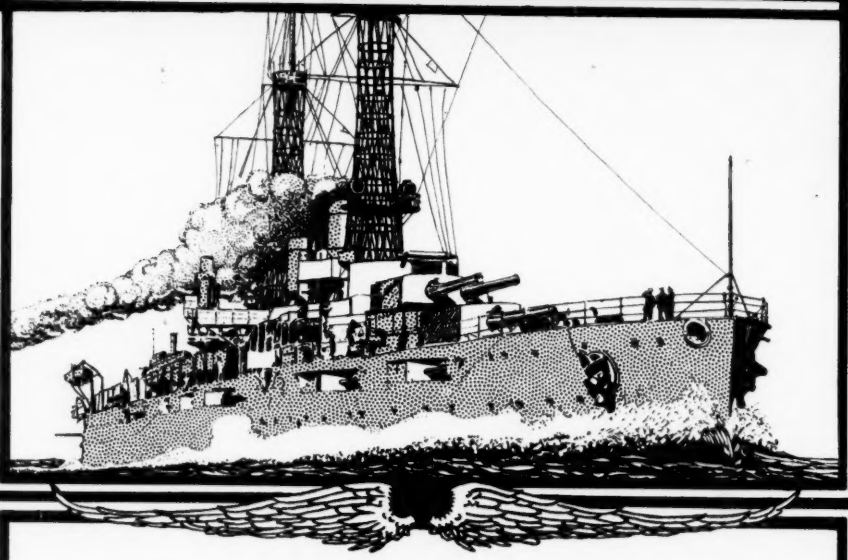
We are glad at all times to supply prices and further information on TEXACO URSA OIL or any lubricants for any purpose whatever.

THE TEXAS COMPANY

DEPT. H, 17 BATTERY PLACE, NEW YORK CITY

HOUSTON CHICAGO NEW YORK

OFFICES IN ALL PRINCIPAL CITIES



TO any of us the dreadnaught, plowing its way through the waves, is always an inspiring sight.

But to the engineer it means even more—he knows something about the size and power of the engines and turbines, something of the high efficiency achieved in the Navy and something of the difficulties encountered in operating this floating fortress under the rigors of high speed and the additional stress and strain due to the pitch and toss of the vessel.

We of The Texas Company have special reason for pride in our efficient battleships.

For years we have been supplying the lubricants which keep engines and turbines and other machinery operating smoothly, efficiently and economically. TEXACO LUBRICANTS are used throughout the Service from the newest and largest first class ships to the little patrol boats, including also destroyers, colliers, submarines and Naval areoplanes.

The service of the oils themselves is complemented by our excellent delivery service.

The same service we render to Uncle Sam is available to any of his nephews on land or sea.

There is a TEXACO LUBRICANT for every purpose.

THE TEXAS COMPANY

HOUSTON CHICAGO NEW YORK

OFFICES IN PRINCIPAL CITIES